Trends Observed for Selected Marine Bird Species during 1993-2002 Winter Aerial Surveys, Conducted by the PSAMP Bird Component (WDFW) in the Inner Marine Waters of Washington State

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Abstract
The marine bird component of the Puget Sound Ambient Monitoring Program (PSAMP) has conducted comparable winter aerial surveys each December and January 1993-2002, addressing portions of all parts of the inner marine waters of Washington. The primary objectives were monitoring of temporal and spatial trends of selected species. The nine-year effort suggests the following:

1. Density indices of most species suggest that some decline is still ongoing, varying by location and species.
2. The southern and central portions of greater Puget Sound contained the highest densities and numbers for certain species such as scoters, but these areas have also showed the greater degree of decline over the last nine years.
3. Scoter species exhibited the largest loss of biomass over this 9-year period.
4. Some species such as goldeneyes, originally thought to be stable when compared over 20 years in the northern waters, are now considered to be slowly declining when examined throughout the inner waters 1993-2002.
5. Harlequin ducks and buffleheads showed a generally stable pattern over the 9-year period.
6. Three merganser species originally thought to be some of the few sea duck species that had increased over 20 years, now appear to exhibit a more stable pattern during 1993-2002 periods.
7. Species, like loons and the various grebe species illustrated by western grebes, that feed more on fish directly show some of the most dramatic declines, with numbers declining severely in certain subregions of Puget Sound.

Methods
Aerial strip transects were flown using a de Havilland DHC-2 Beaver during December and January 1993 – 2002. Strip width was 50m on each side of aircraft for a total of 100m. Two types of transects were flown; a strip 100m parallel to nearly all shoreline, and a general random pattern in the offshore areas designed to cross over depth contours (Figure 1).

Marine areas were broken into several geographic sub-regions with similar habitat features, and these areas were stratified into a nearshore strata (<20 m depth) and an offshore strata (>20m depth). Density trends for all sea ducks were calculated, for specific sub-regions and region wide, throughout the inland marine waters of Washington State.

Data presented here for the sea duck species is from the nearshore strata only, as the majority of sea ducks are concentrated in these strata. Surveys covered on average 17% of the nearshore strata on any given year. Sea duck densities were too varied in the offshore strata as it consisted of all depths >20 m; this strata could be used in the future if it were broken up into more detailed depth zones. Data presented for loon species combined and western grebes includes both nearshore and offshore strata since their distribution pattern is different than that of sea ducks.

Results
Figures 2 (a-j) depict the overall mean density indices (with 95% C.L.) for 10 species charted through the 1993-2002 period, all survey areas combined each year. The inner marine waters of Washington were divided up into 5 sub-regions for comparison of bird populations and figures 3 (a-j) look at changes varied in density indices by year for six sea duck species in each of these five sub-regions. Figures 4 (a-j) looks at the sub-regional differences by 10 species, including three loon species and one grebe species, along with the six sea duck species.

Summaries of Sub-regional Trends in Density Indices

Bufflehead:
While Bufflehead densities appear to be generally stable overall in the inner marine waters, some declines were noted in the Marine Ecosystem Analysis (MESA) portion of northern Puget Sound. No trend in other sub-regions is obvious from the inter-annual fluctuations recorded.

Goldeneyes (Barrow's and Common Goldeneyes):
Goldeneyes are likely experiencing a gradual decline region-wide, with the most evident declines noted for these species in the southern and central Puget Sound sub-regions. The degree of inter-annual fluctuation noted in other sub-regions suggests no observable trend.

Harlequin duck:
Harlequin Duck densities appear to be relatively stable region-wide, with a possible slight increase in the MESA portion of northern Puget Sound. However, a noticeable decline has been observed in the Whidbey-Camano Islands portion (1400) of northern Puget Sound.

Long-tailed duck:
Long-tailed duck densities are low, but have been relatively stable 1993-2002. The largest proportion was observed in the MESA portion of northern Puget Sound. All other areas were observed with much lower densities of this species.

Mergansers (common, red-breasted, booted mergansers):
Merganser densities seem to be relatively stable, with no sign of increasing densities during 1993-2002. Densities have fluctuated most in southern and central Puget Sound.

Scoters (black, surf, and white-winged scoters):
Scoter densities have been decreasing region-wide. The southern Puget Sound and 1400 portion (waters east of Whidbey Island that include Skagit Bay, Saratoga Passage, Port Susan, and Possession Sound) of northern Puget Sound sub-regions have experienced the greatest declines during the past nine years, while Hood Canal has undergone an intermediate decline. The scoter densities in central Puget Sound and MESA portion of northern Puget Sound sub-regions exhibited a more stable pattern.

Loons (common, red-throated, and Pacific loons):
Loon densities, generally described as decreasing region-wide during the last 20 years, have shown some differentiating trends in recent years. Common loon densities, even though low, have shown some slight recovery while red-throated loons have exhibited even more dramatic decreases since 1999. This latter species tends to associate more with the nearshore in shallower bays and estuaries. The density indices of Pacific loons are more variable, with some possible increases in the MESA portions of the northern as well as central Puget Sound sub-regions.

Western grebe (may also include small numbers of Clark's grebe):
While all four grebe species seen on marine waters in winter have experienced significant declines in the last 20 years, the decline in densities of Western grebes is most striking. The southern Puget Sound, Hood Canal, and 1400 portions of the northern Puget Sound sub-regions have experienced the greatest declines during the past nine years. The Western Grebe densities in central Puget Sound near Bainbridge Island exhibited a more stable pattern in recent years.

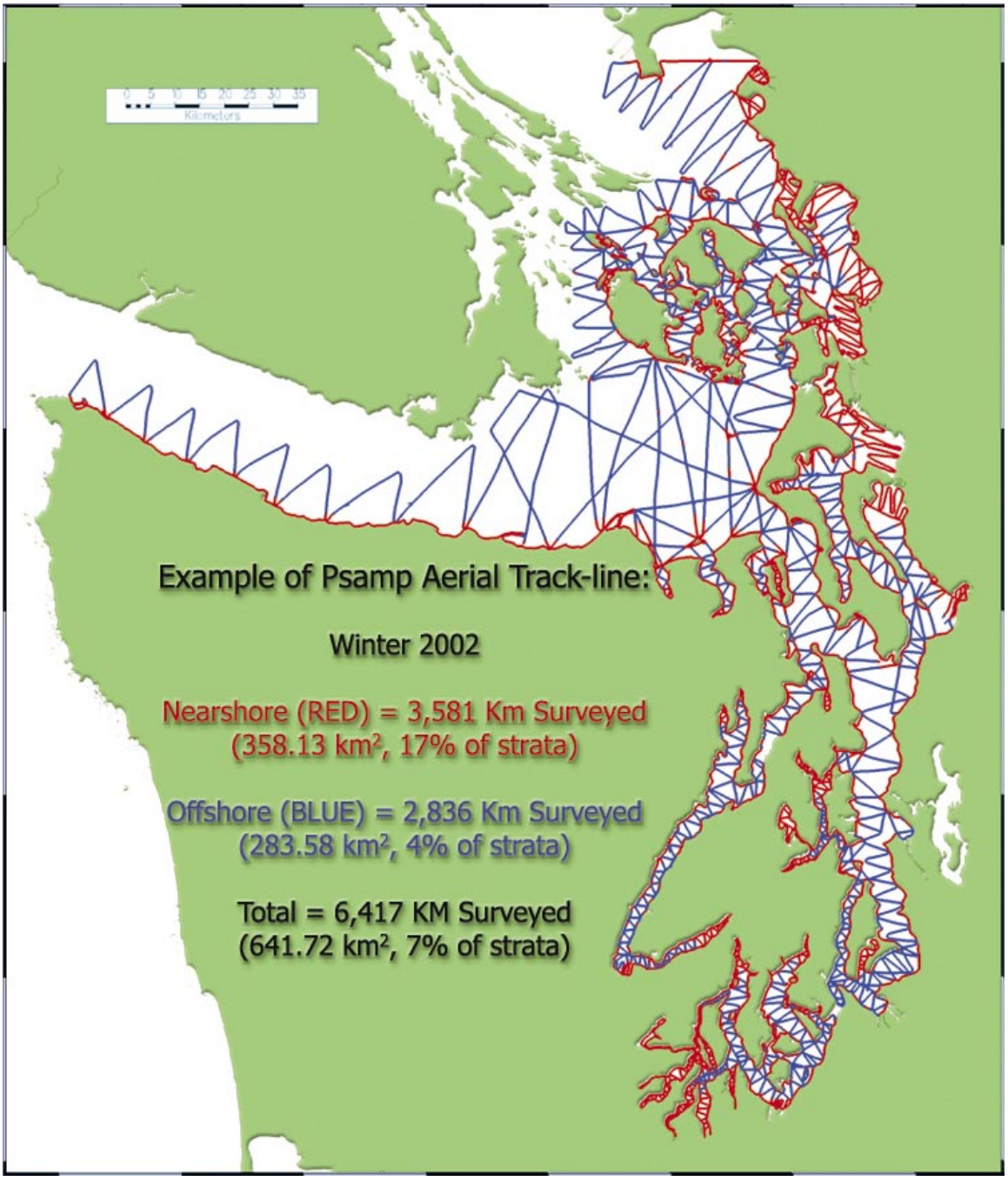


Figure 1. Example of Aerial Survey Track Line Conducted by PSAMP.

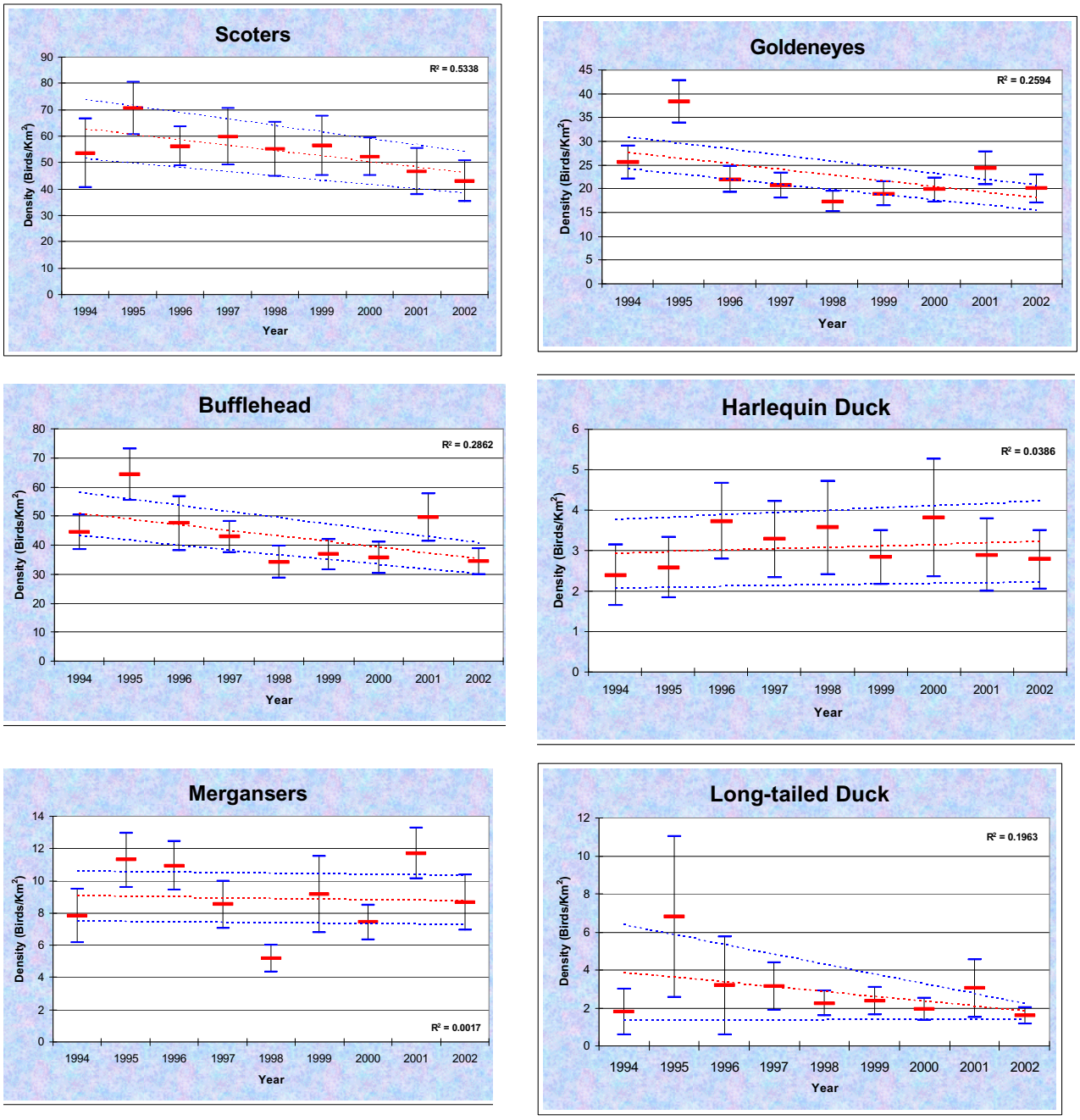


Figure 2. Trends in Density Indices of Sea Ducks (nearshore) and Loons/Western Grebes (offshore and nearshore combined) in the Inland Marine Waters of Washington State, 1993-2002, 95% Confidence Limits are Displayed.

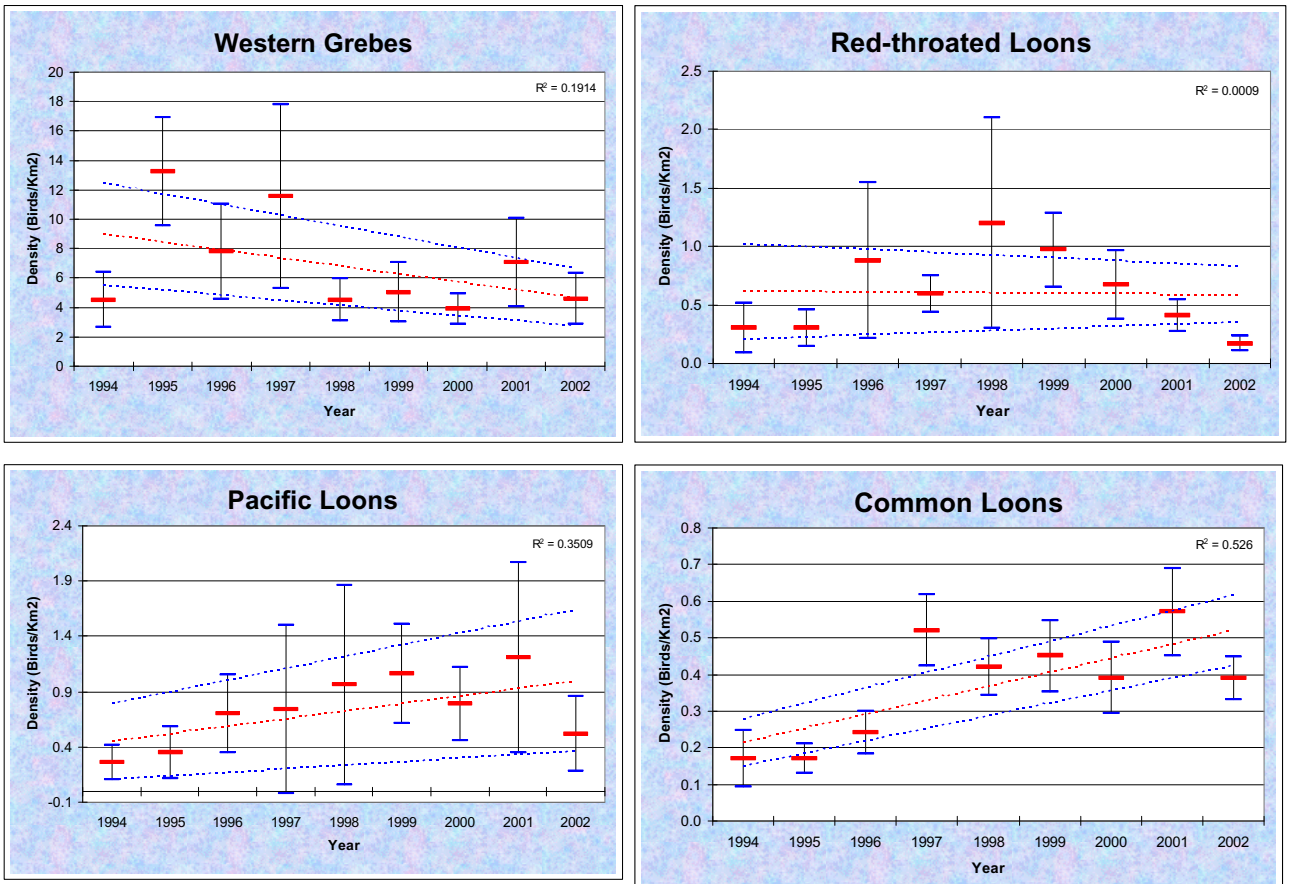


Figure 2, *continued,*

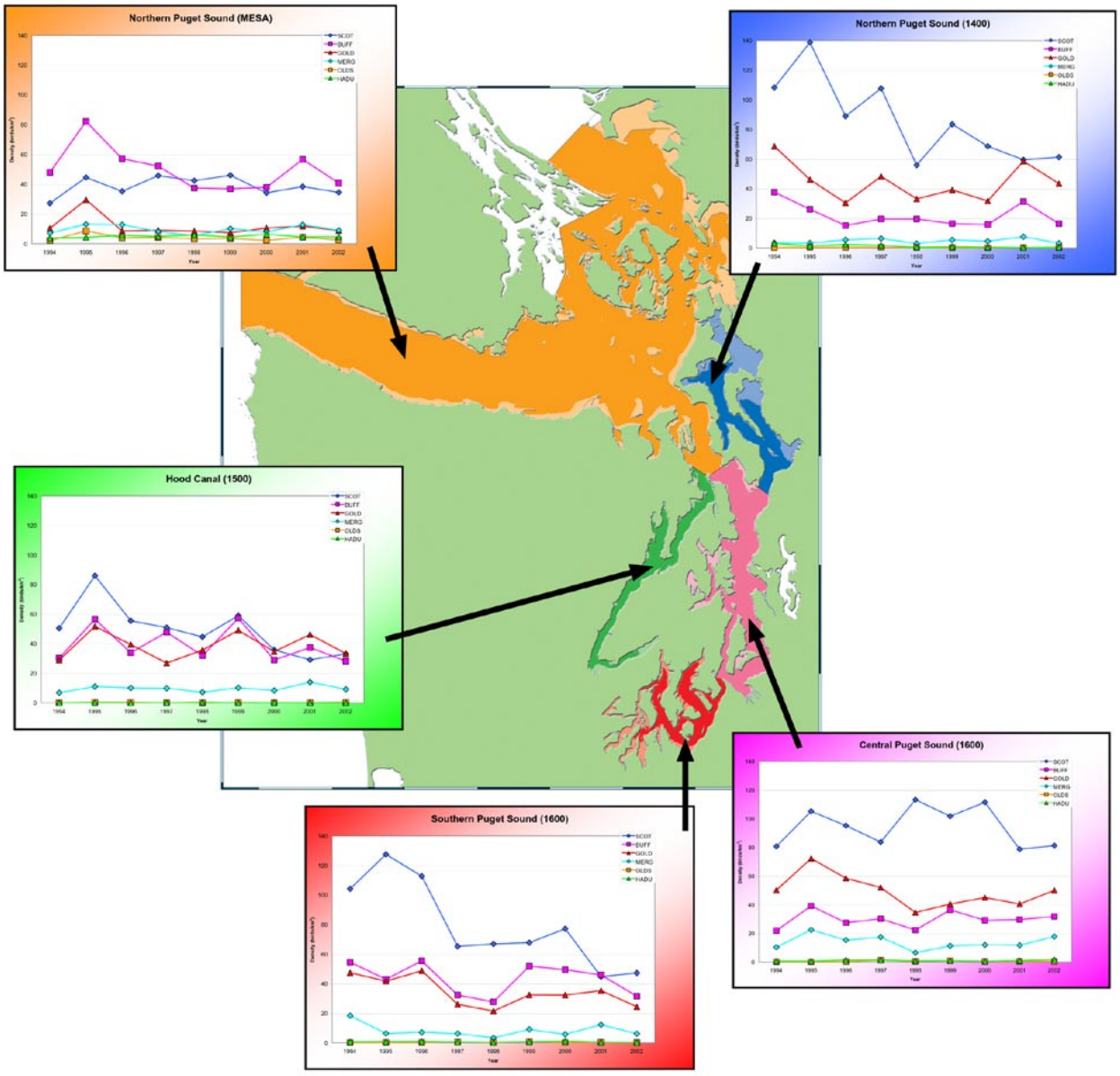
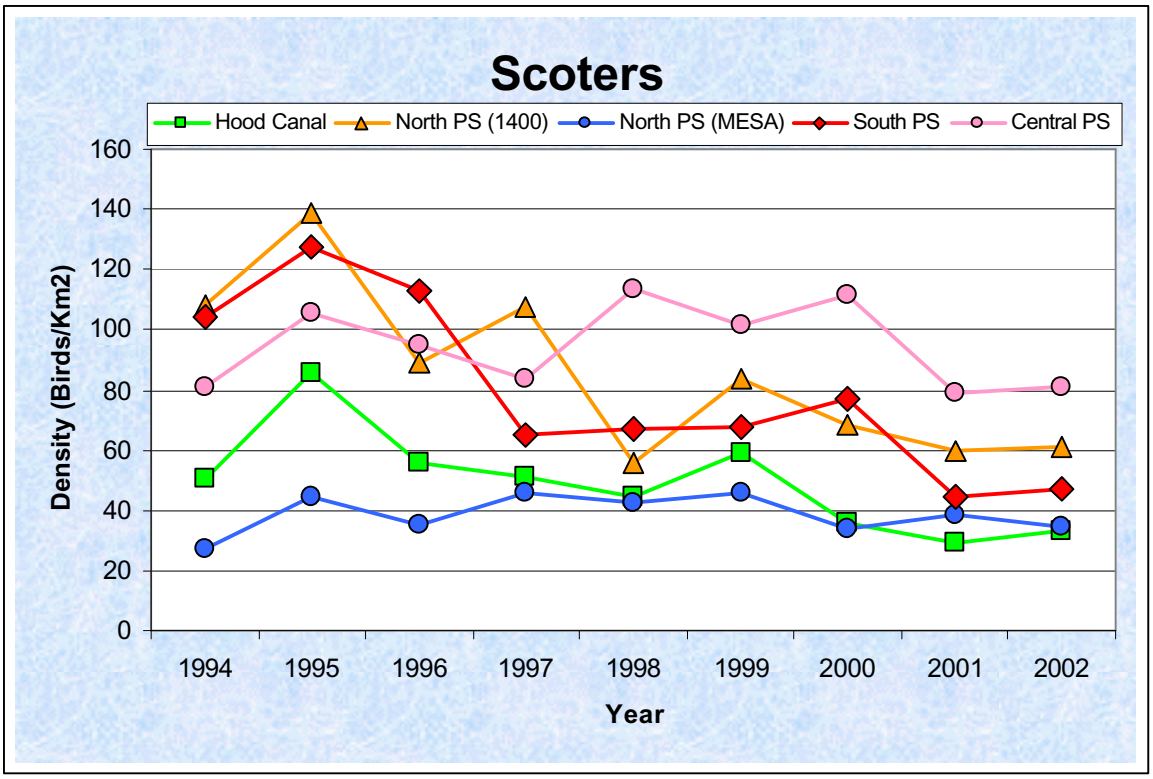
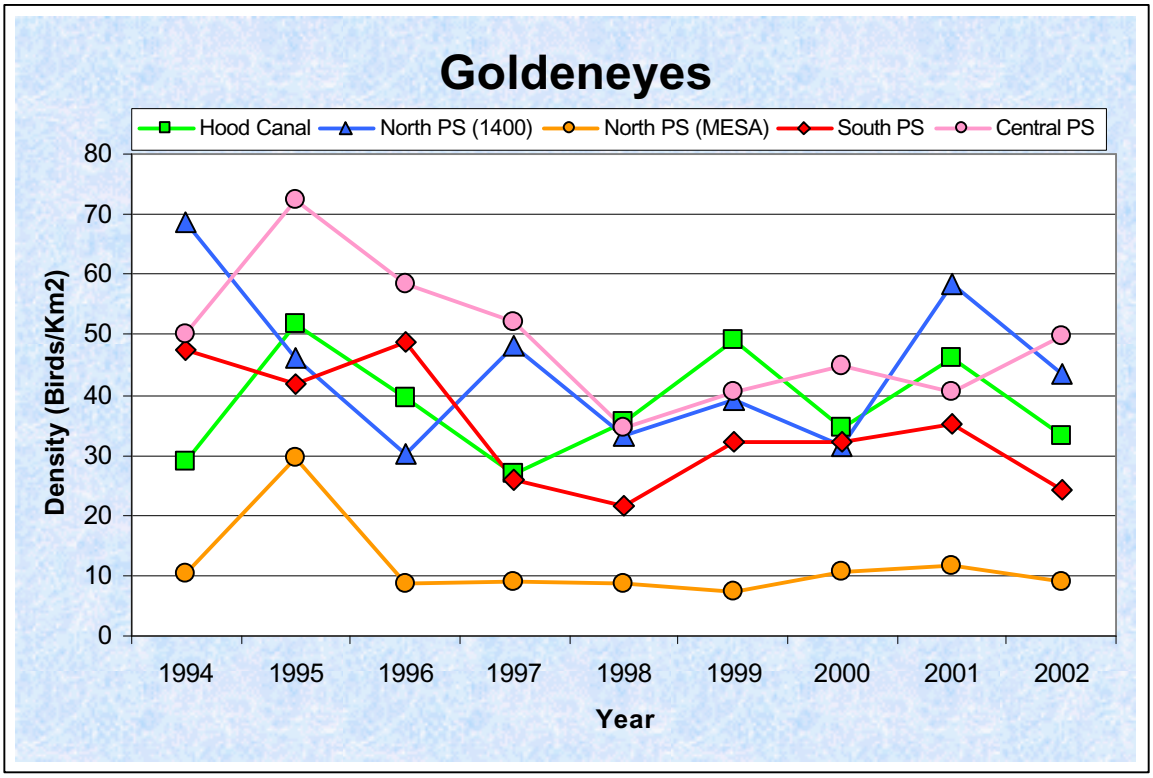
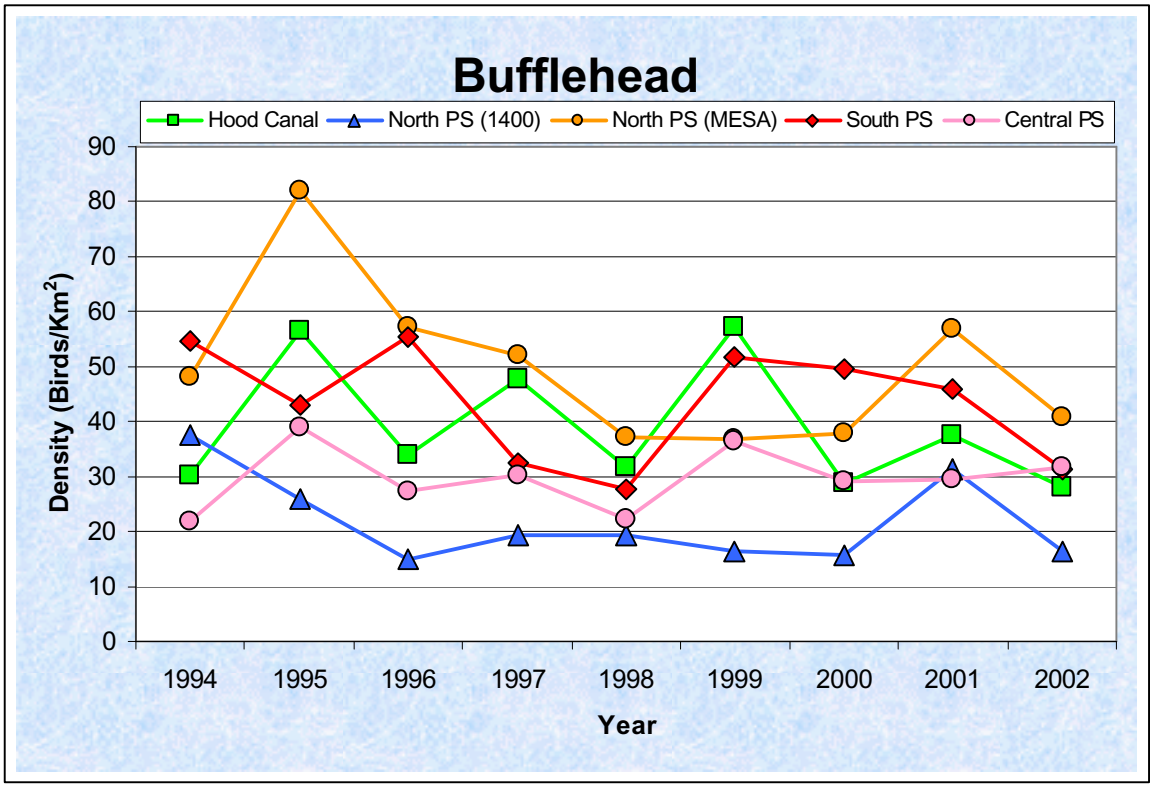


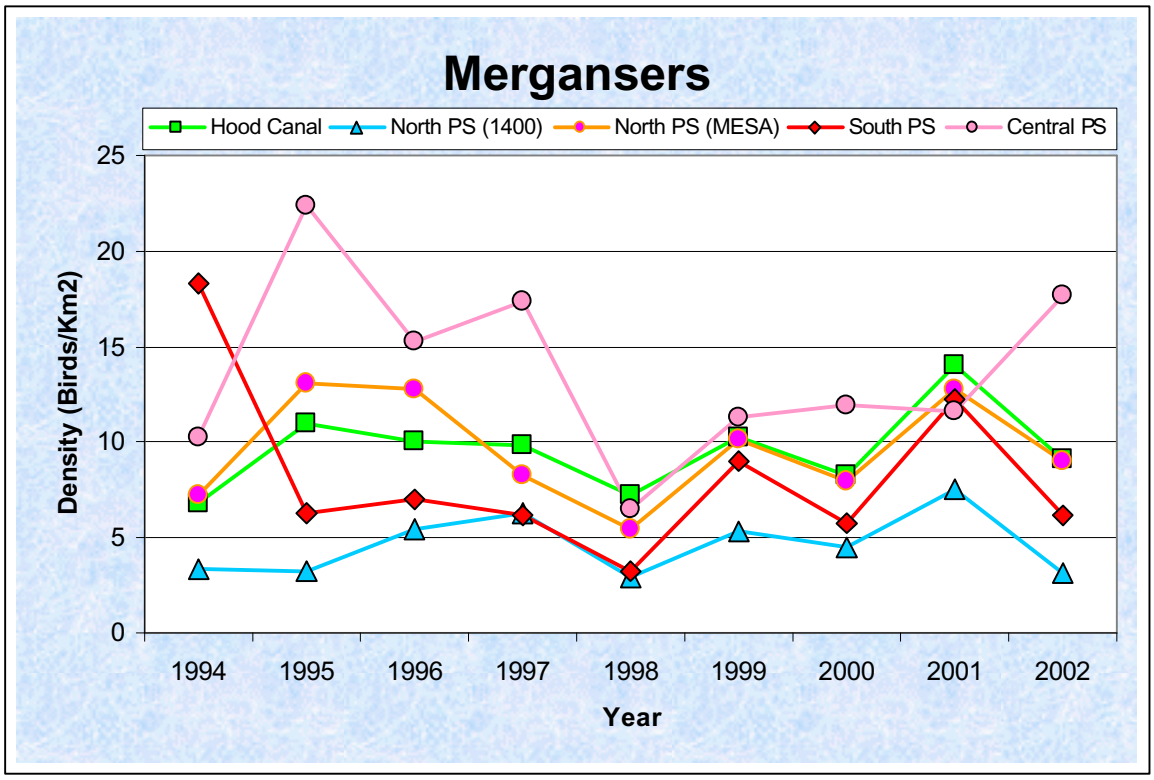
Figure 3. (includes 5 graphs and a map). Sea duck Nearshore Density Trends for Selected Regions by Species, from winter aerials 1993-2002. Lightly Shaded Zones along the Shoreline Depict the Nearshore Habitat (<20m Depth).

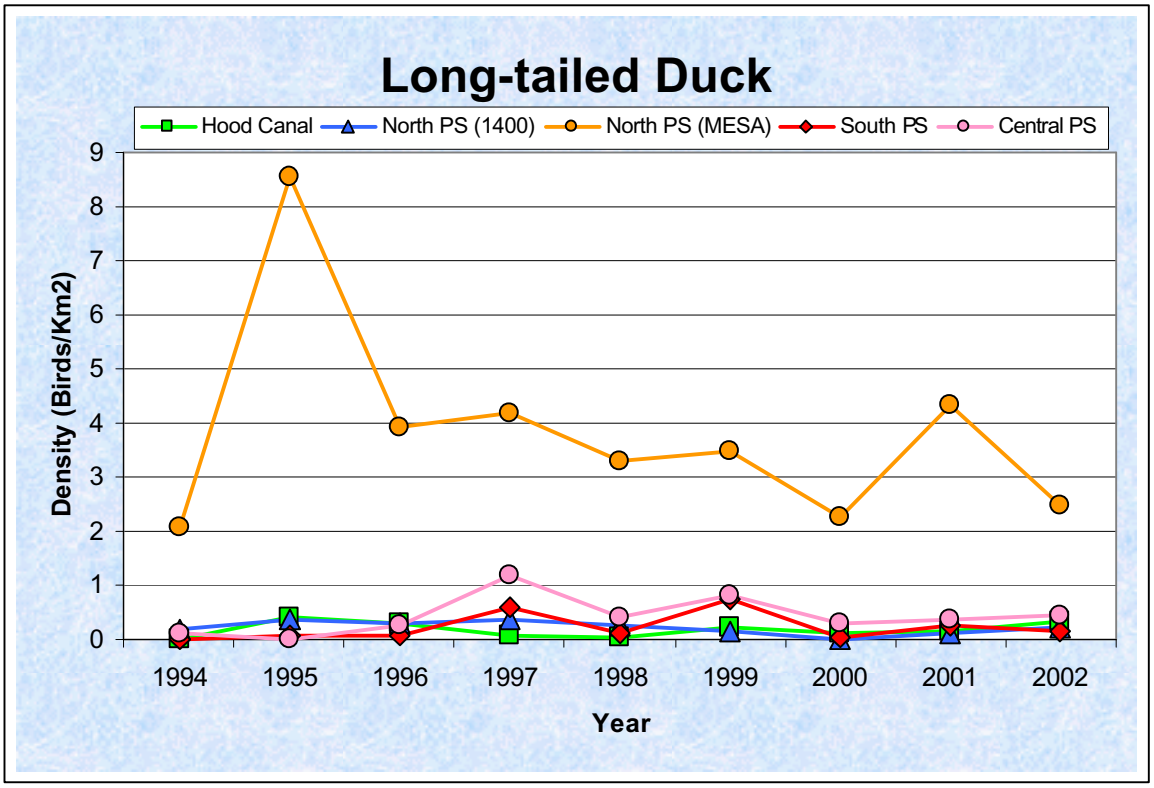
Figure 4 (Graphs continue on following pages). Regional Comparisons of Winter Sea Duck Densities (in the Nearshore) and Loons and Western Grebes (in both strata) of the Inland Marine Waters Of Washington State, 1993-2002, by Species / Species Group.

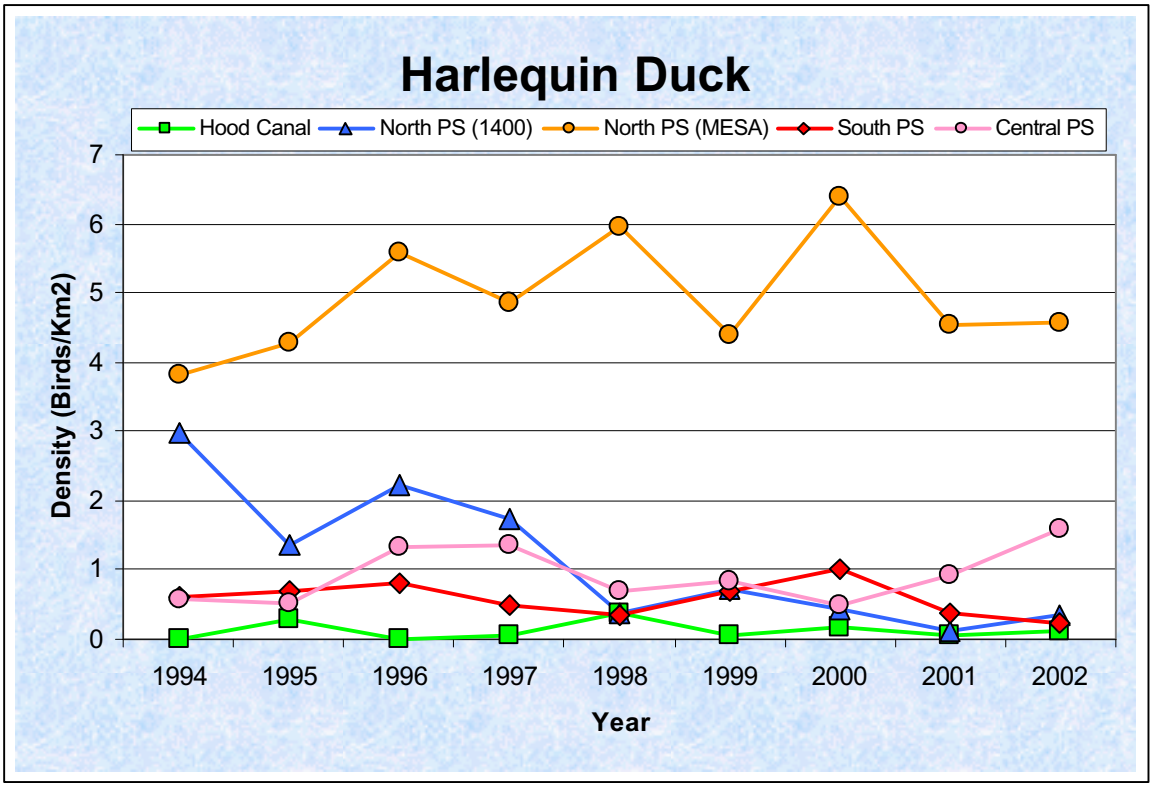


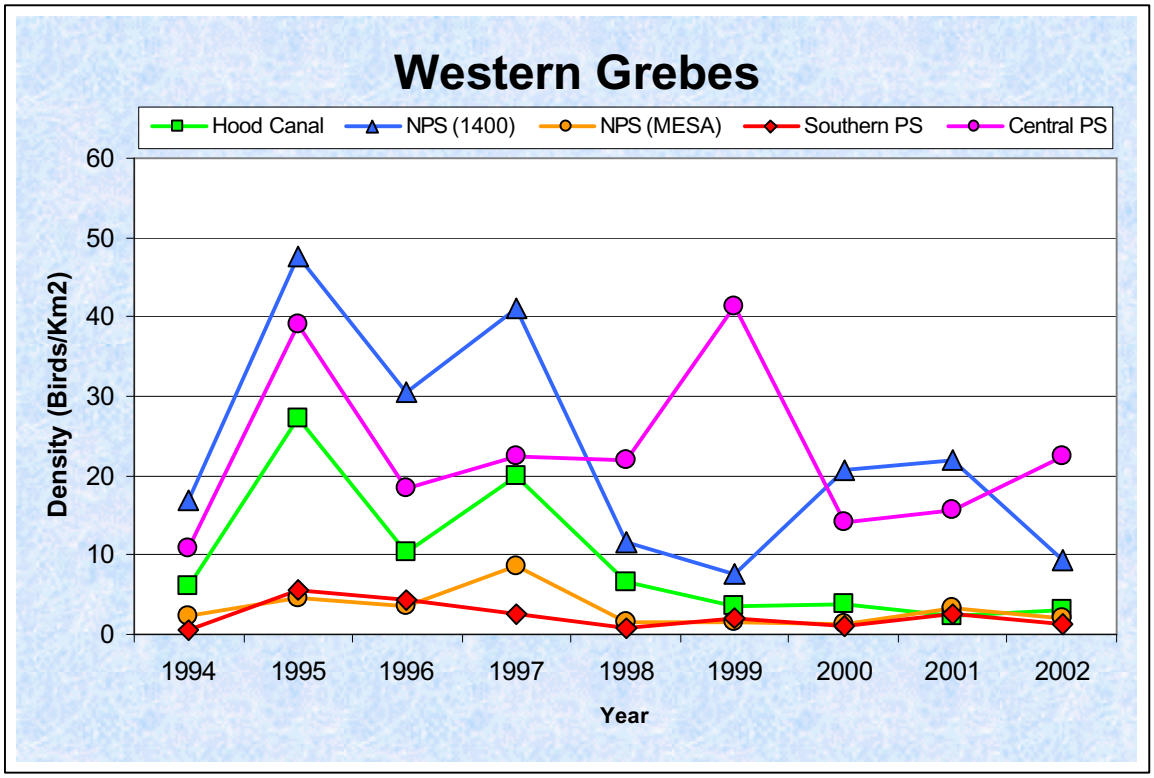


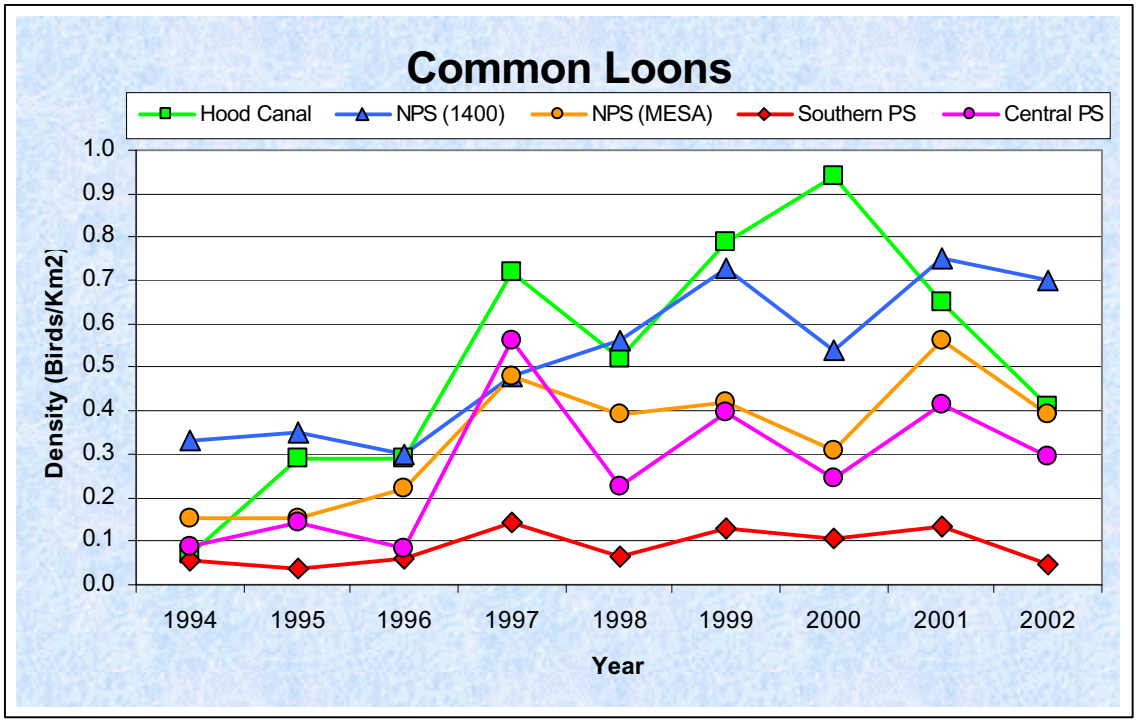

Bufflehead
Hood Canal
North PS (1400)
North PS (MESA)
South PS
Central PS
Density (Birds/Km2)
0
10
20
30
40
50
60
70
80
90
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year

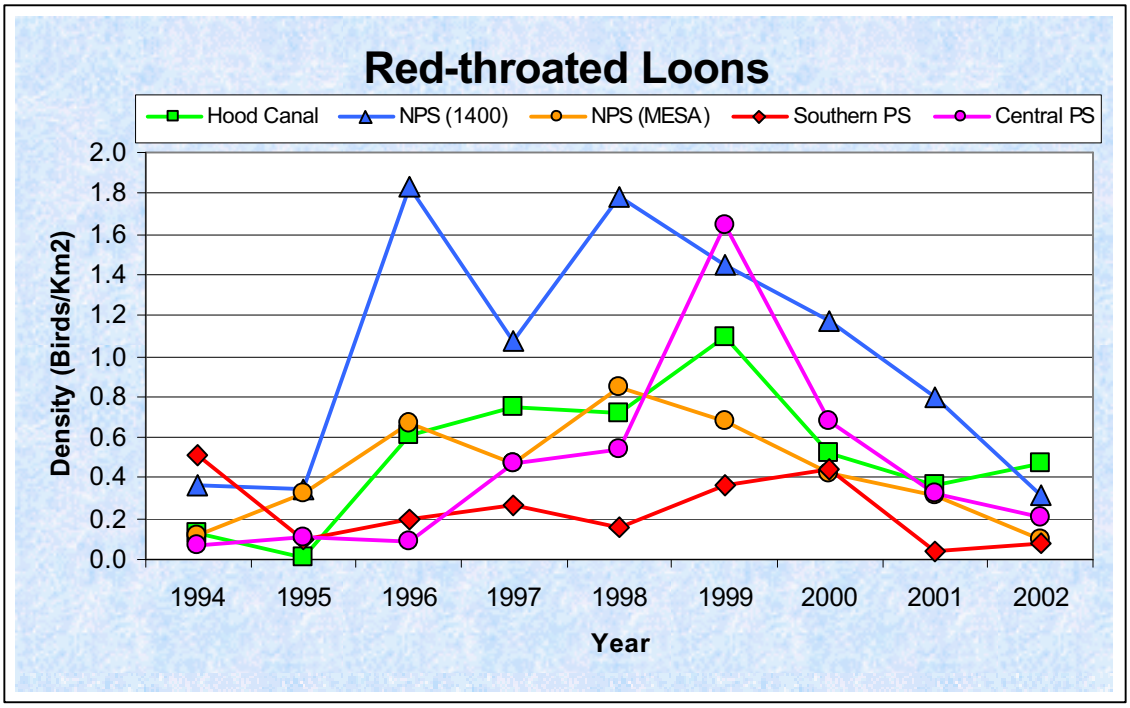

Mergansers
Hood Canal
North PS (1400)
North PS (MESA)
South PS
Central PS
Density (Birds/Km2)
0
5
10
15
20
25
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year

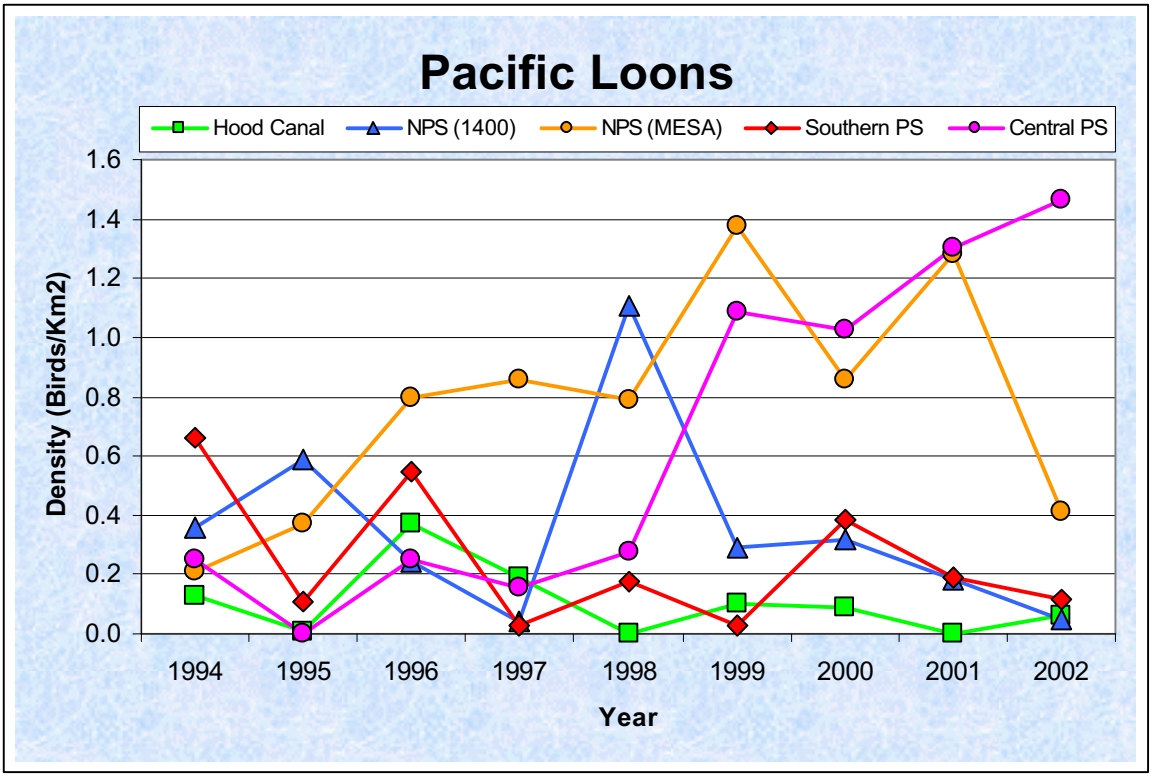

Long-tailed Duck
Hood Canal
North PS (1400)
North PS (MESA)
South PS
Central PS
Density (Birds/Km2)
0
1
2
3
4
5
6
7
8
9
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year


Harlequin Duck
Hood Canal
North PS (1400)
North PS (MESA)
South PS
Central PS
Density (Birds/Km2)
0
1
2
3
4
5
6
7
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year


Western Grebes
Hood Canal
NPS (1400)
NPS (MESA)
Southern PS
Central PS
Density (Birds/Km2)
60
50
40
30
20
10
0
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year


Common Loons
Hood Canal
NPS (1400)
NPS (MESA)
Southern PS
Central PS
Density (Birds/Km2)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year


Red-throated Loons
Hood Canal
NPS (1400)
NPS (MESA)
Southern PS
Central PS
Density (Birds/Km2)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year


Pacific Loons
Hood Canal
NPS (1400)
NPS (MESA)
Southern PS
Central PS
Density (Birds/Km2)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year